



**Fermi National Accelerator Laboratory
Batavia, IL 60510**

FERMI MAIN INJECTOR

3Q60 COIL ASSEMBLY/INSULATION TRAVELER

Reference Drawing(s)

**3Q60 Half-Coil Assembly MD-331984
3Q60 Complete Coil Assembly MD-331966**

Budget Code: MYI

Project Code: CII

Released by:

Date:

Prepared by: W. L. Isiminger

Title	Signature	Date
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TD / E&F Assembly	<i>Samuel</i>	7/13/98
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TD / E&F Fabrication Manager	<i>Marion</i>	7/13/98
TD / E&F Device Design	<i>Michael</i>	7/13/97
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Revision Page

<u>Revision</u>	<u>Revision Description</u>	<u>Date</u>
A	Step 3.7: Added Ls and Q limits for 100 Hz measurements per unreleased specification ES-331810 Rev. D received from D. Gaw. TRR. No. 0860	07/09/98

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

- 1.1 White (Lint-Free) Gloves (Fermi stock 2250-1800) or Surgical Latex Gloves (Fermi stock 2250-2494) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.
- 1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.
- 1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.
- 1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.
- 1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.
- 1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.
- 1.7 Cover the 3Q60 Coil Assembly with green Herculite (Fermi stock 1740-0100) when not being serviced or assembled. Completed coils are to be stored in the 3Q60 Coil Storage Area.

2.0 Parts Kit List

- 2.1 Attach the completed Parts Kit List for the 3Q60 Coil Assembly/Insulation to this traveler. Ensure that the serial number on the Parts Kit List matches the serial number of this traveler. Verify that the Parts Kit received is complete.

Process Engineering/Designee

Date

3.0 Pre-Assembly Inspection**Note(s):**

When lifting and or moving coils or coil assemblies always have the four (4) Ty-Raps (Fermi stock 1150-2080 or equivalent) installed at the quarter points of the coil or coil assembly.

- X 3.1 Transport two (2) 3Q60 Outer (small) Coil Assemblies (ME-331982) supported on tape wrapped 2 x 4's from the coil staging area on a coil transport cart to the coil insulating area. Visually inspect the coils conductor wrap for damage and ensure the G-10 insulation is between the layers of the coils. Record the serial numbers of the coils below.

Record the Outer Coil Serial Number:	
Record the Outer Coil Serial Number:	

Lead Person_____
Date

- X 3.2 Verify that the "OK to Proceed" tags are attached to the coils. Remove the tags and attach them to this traveler.

Lead Person_____
Date

- X 3.3 Transport two (2) 3Q60 Inner (large) Coil Assemblies (ME-331983) supported on tape wrapped 2 x 4's from the coil staging area on a coil transport cart to the coil insulating area. Visually inspect the coils conductor wrap for damage and ensure the G-10 insulation is between the layers of the coils. Record the serial numbers of the coils below.

Record the Inner Coil Serial Number:	
Record the Inner Coil Serial Number:	

Lead Person_____
Date

- X 3.4 Verify that the "OK to Proceed" tags are attached to the coils. Remove the tags and attach them to this traveler.

Lead Person_____
Date

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- X 3.5 Visually inspect all four (4) of the coils for the following, which will include but not be limited to, all the materials must be clean, dry, free from grease, oils, etc., the insulation is free of damage and there is no exposed copper except that of the leads. In the event repairs are required, indicated the coil serial number requiring the repair, give a detailed description of the repair required and the repair location for each coil requiring repair below.

None Required

☐

All coils acceptable for use go to Step 3.7.

Lead Person_____
Date

- 3.6 The repairs listed in step 3.5 have been completed.

Technician(s)_____
Date

Note(s):

This test is only required if the coils have been in storage for more than 24 hours. If work is continuous no electricals are required, but the visual inspections must be done.

- X. 3.7 Perform a Coil Integrity Electrical inspection and record the results below. Compare the results with the post conductor wrap electrical. The coils must be clamped for the following tests.

Inner Coil Serial Number						
Electrical Test	Equipment/Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		6.0 mΩ to 6.8 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		103 μH to 113 μH				
Q @ 100 Hz		7.5 to 8.5				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Visually inspect the coil for the following, which will include but not be limited to:

- | | | | | |
|--|------|--------------------------|------|--------------------------|
| All materials must be clean, dry, free from grease, oils, etc. | Pass | <input type="checkbox"/> | Fail | <input type="checkbox"/> |
| The insulation is free of damage and there is no exposed copper. | Pass | <input type="checkbox"/> | Fail | <input type="checkbox"/> |
| There is G-10 placed between the layers of the coil along the straight sections. | Pass | <input type="checkbox"/> | Fail | <input type="checkbox"/> |
| The G-10 is roughened to enhance bonding with the epoxy. | Pass | <input type="checkbox"/> | Fail | <input type="checkbox"/> |
| The coil serial number is not covered by insulation. | Pass | <input type="checkbox"/> | Fail | <input type="checkbox"/> |

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Inner Coil Serial Number						
Electrical Test	Equipment Serial Number	Limits	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		6.0 mΩ to 6.8 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		103 μH to 113 μH				
Q @ 100 Hz		7.5 to 8.5				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Visually inspect the coil for the following, which will include but not be limited to:

All materials must be clean, dry, free from grease, oils, etc. Pass ☐ Fail ☐

The insulation is free of damage and there is no exposed copper. Pass ☐ Fail ☐

There is G-10 placed between the layers of the coil along the straight sections. Pass ☐ Fail ☐

The G-10 is roughened to enhance bonding with the epoxy. Pass ☐ Fail ☐

The coil serial number is not covered by insulation. Pass ☐ Fail ☐

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Outer Coil Serial Number						
Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		3.3 mΩ to 3.7 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		33 μH to 41 μH				
Q @ 100 Hz		5.0 to 6.0				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Visually inspect the coil for the following, which will include but not be limited to:

All materials must be clean, dry, free from grease, oils, etc. Pass ☐ Fail ☐

The insulation is free of damage and there is no exposed copper. Pass ☐ Fail ☐

There is G-10 placed between the layers of the coil along the straight sections. Pass ☐ Fail ☐

The G-10 is roughened to enhance bonding with the epoxy. Pass ☐ Fail ☐

The coil serial number is not covered by insulation. Pass ☐ Fail ☐

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Outer Coil Serial Number						
Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		3.3 mΩ to 3.7 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		33 μH to 41 μH				
Q @ 100 Hz		5.0 to 6.0				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Visually inspect the coil for the following, which will include but not be limited to:

All materials must be clean, dry, free from grease, oils, etc.

Pass ☐ Fail ☐

The insulation is free of damage and there is no exposed copper.

Pass ☐ Fail ☐

There is G-10 placed between the layers of the coil along the straight sections.

Pass ☐ Fail ☐

The G-10 is roughened to enhance bonding with the epoxy.

Pass ☐ Fail ☐

The coil serial number is not covered by insulation.

Pass ☐ Fail ☐

Inspector _____

Date _____

- XX** 3.8 Verify the electrical results and visual inspections are acceptable and the coil can proceed to the next step. Attach temporary coil identifiers to each coil as indicated in the table below.

ID	Coil Serial Number	Coil Type
1		Outer Coil (ME-331982) (5 Turn Small Coil)
2		Inner Coil (ME-331983) (9 Turn Large Coil)
3		Outer Coil (ME-331982) (5 Turn Small Coil)
4		Inner Coil (ME-331983) (9 Turn Large Coil)

Lead Inspector _____

Date _____

Crew Chief _____

Date _____

4.0 Half Coil Assembly/Conductor Wrap Procedure**Note(s):**

When lifting and or moving coils or coil assemblies always have the four (4) Ty-Raps (Fermi stock 1150-2080 or equivalent) installed at the quarter points of the coil or coil assembly.

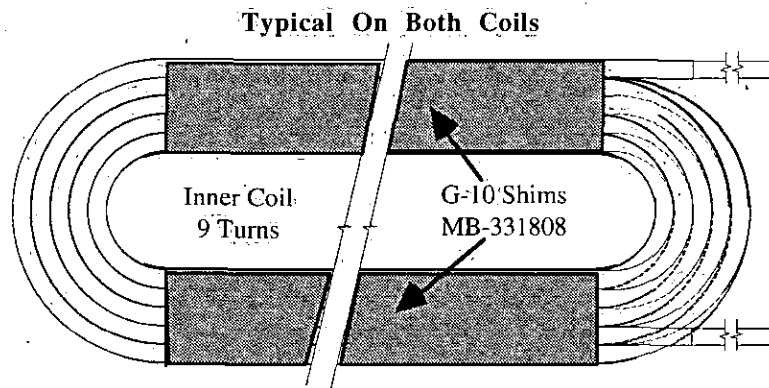
Ensure the G-10 pieces have been roughed to enhance bonding with the epoxy.

Ensure that the part numbers have been removed. Ensure that the area about to be wrapped and the G-10 is clean, dry, free from grease, oils, etc...

Ensure that the G-10 parts are clean, if not use Isopropyl Alcohol (Fermi stock 1920-0300) and Heavy Disposable Wipers (Fermi stock 1660-2600 or equivalent).

- 4.1 Set the two (2) Inner Coils (ME-331983) on separate wrapping tables. Remove the Ty-Raps from the inner coils and the Kapton tape used to mark the joint locations on the inner coils. Longitudinally position on top of the inner coils G-10 Sheet Insulation (MB-331808) (Qty. 2), one per side of the long straight sections as indicated by MD-331984.

ID	Coil Type	Completed
2	Inner Coil (ME-331983) (9 Turn Large Coil)	
4	Inner Coil (ME-331983) (9 Turn Large Coil)	



Technician(s)

Date

July 9, 1998.

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Note(s):

When lifting and or moving coils or coil assemblies always have the four (4) Ty-Raps (Fermi stock 1150-2080 or equivalent) installed at the quarter points of the coil or coil assembly.

Exercise extreme caution in the following step to ensure that no damage occurs to the insulation, or leads of the inner and outer coil packages.

The leads of both half coil assemblies must exit at the same end of the full coil assembly.

- 4.2 Using the overhead crane and approved lifting method, centrally position the outer coils on top of the inner coils per MD-331984 (One (1) outer coil to One (1) inner coil), remove the Ty-Raps and Kapton tape used to mark the joint locations on the outer coils. Using c-clamps or other approved clamping methods, clamp the coils into position aligning the inside radii of the coils with each other.

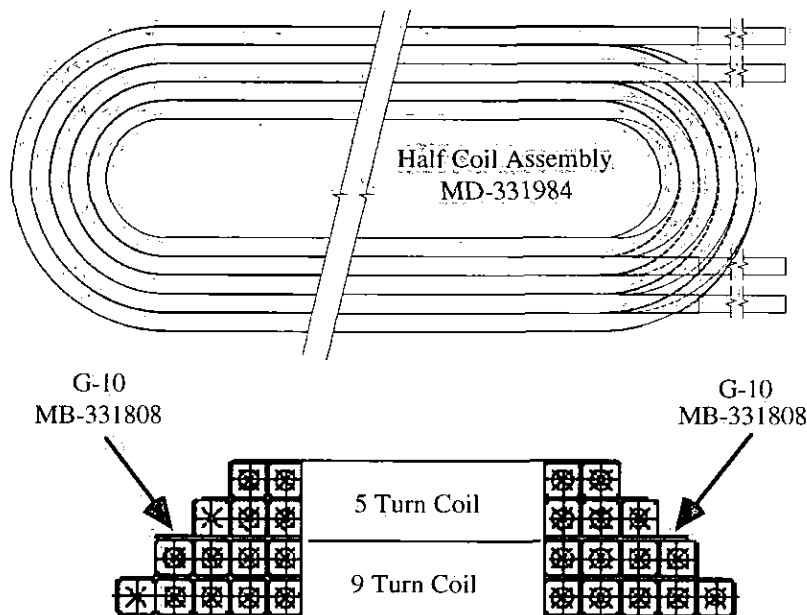
Note(s):

The leads of both half coil assemblies must exit at the same end of the full coil assembly.

Caution:

This operation represents a pinch hazard.

ID	Coil Type	Completed
1	Outer Coil (ME-331982) (5 Turn Small Coil)	
On Top Of 2	Inner Coil (ME-331983) (9 Turn Large Coil)	
3	Outer Coil (ME-331982) (5 Turn Small Coil)	
On Top Of 4	Inner Coil (ME-331983) (9 Turn Large Coil)	



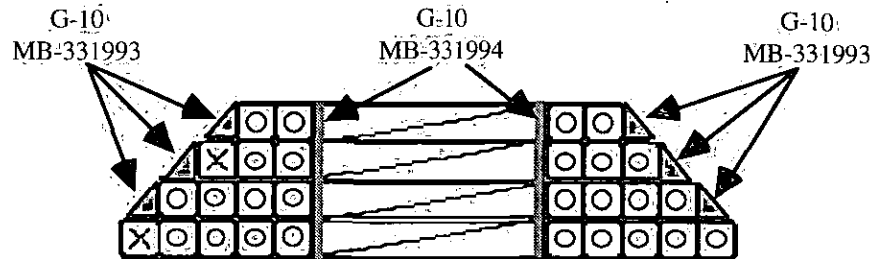
Technician(s) _____

Date _____

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- 4.3 Position six (6) pieces of G-10 (MB-331993) along the steps of the straight sections of the coil and two (2) pieces of G-10 (MB-331994) along the inside straight sections of the coil. Use 1/2" X .007" Fiberglass Adhesive Back Tape (MA-225104) as required to hold the G-10 pieces in place as per MD-331984.



ID	Coil Type	Operation	Completed
1 And 2	Half-Coil Assembly (MD-331984) (14 Turn Coil)	G-10 In Place	
3 And 4	Half-Coil Assembly (MD-331984) (14 Turn Coil)	G-10 In Place	

Technician(s)

Date

- X 4.4 Visually verify that step 4.1 through 4.3 have been completed and that the coil packages comply with MD-331984.

Lead Inspector

Date

July 9, 1998

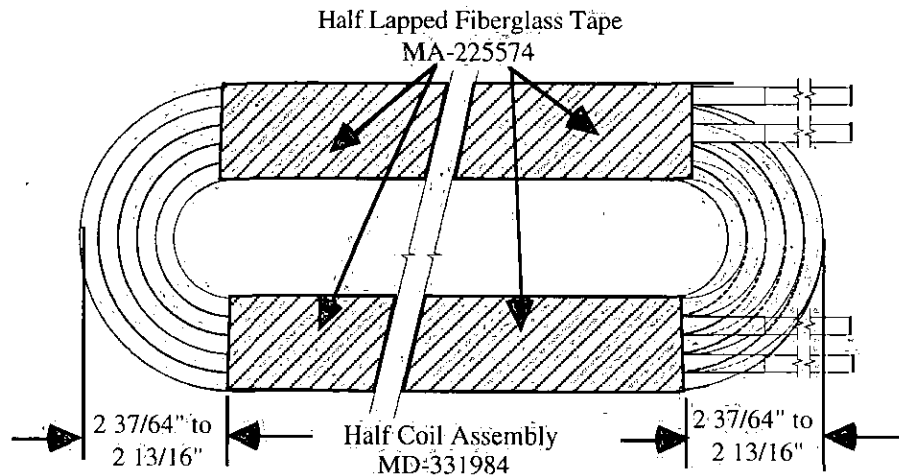
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- 4.5 Starting $2\frac{37}{64}$ " to $2\frac{13}{16}$ " in from the end of the coil, conductor wrap one (1) layer half lapped Fiberglass Tape .007 X 2" (MA-225574) along the coils straight sections only, stopping $2\frac{37}{64}$ " to $2\frac{13}{16}$ " from the other end of the coil. Remove the clamps and the Fiberglass adhesive back tape as required to wrap the coils.

Note(s):

The Fiberglass tape used to hold the G-10 in place prior to wrapping is to be removed and not wrapped into the coil assembly.

ID	Coil Type	Operation	Completed
1 And 2	Half-Coil Assembly (MD-331984) (14 Turn Coil)	Insulated	
3 And 4	Half-Coil Assembly (MD-331984) (14 Turn Coil)	Insulated	



Technician(s)

Date

XX

- 4.6 Visually verify that step 4.1 through 4.5 have been completed and that the coil packages comply with MD-331984.

Lead Inspector

Date

Crew Chief

Date

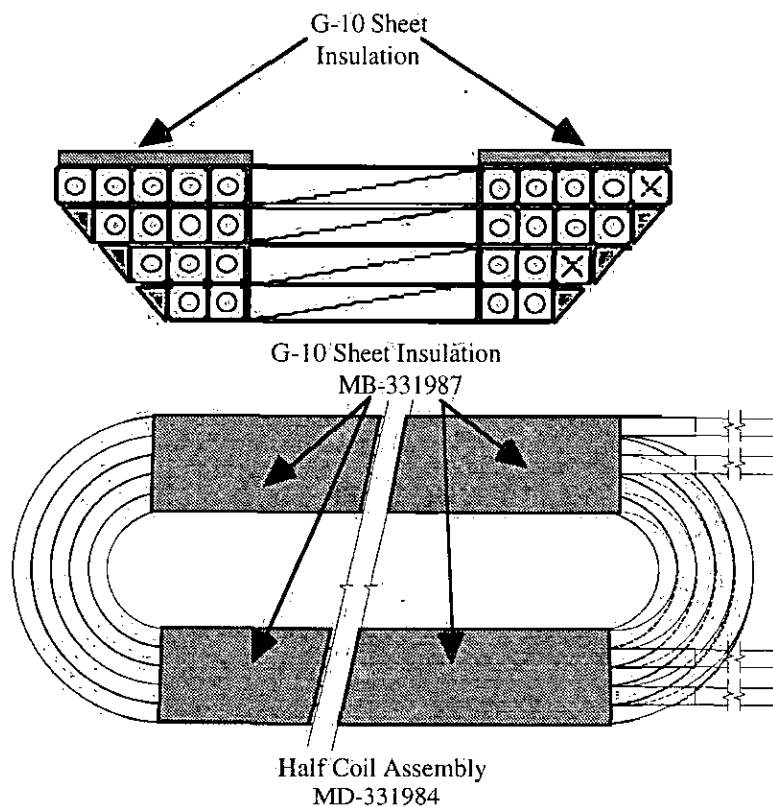
5.0 Full Coil Assembly/Ground Wrap Procedure**Note(s):**

Ensure the G-10 pieces have been roughed to enhance bonding with the epoxy.

Ensure that the part numbers have been removed. Ensure that the area about to be wrapped and the G-10 is clean, dry, free from grease, oils, etc...

Ensure that the G-10 parts are clean, if not use Isopropyl Alcohol (Fermi stock 1920-0300) and Heavy Disposable Wipers (Fermi stock 1660-2600 or equivalent).

- 5.1 Using the overhead crane and the appropriate slings, invert one of the half coil assemblies and place it on the wrapping stands. Longitudinally position on top of the coil two (2) pieces of G-10 Sheet Insulation (MB-331987), one per side of the long straight sections as indicated by MD-331966:

_____
Technician(s)_____
Date

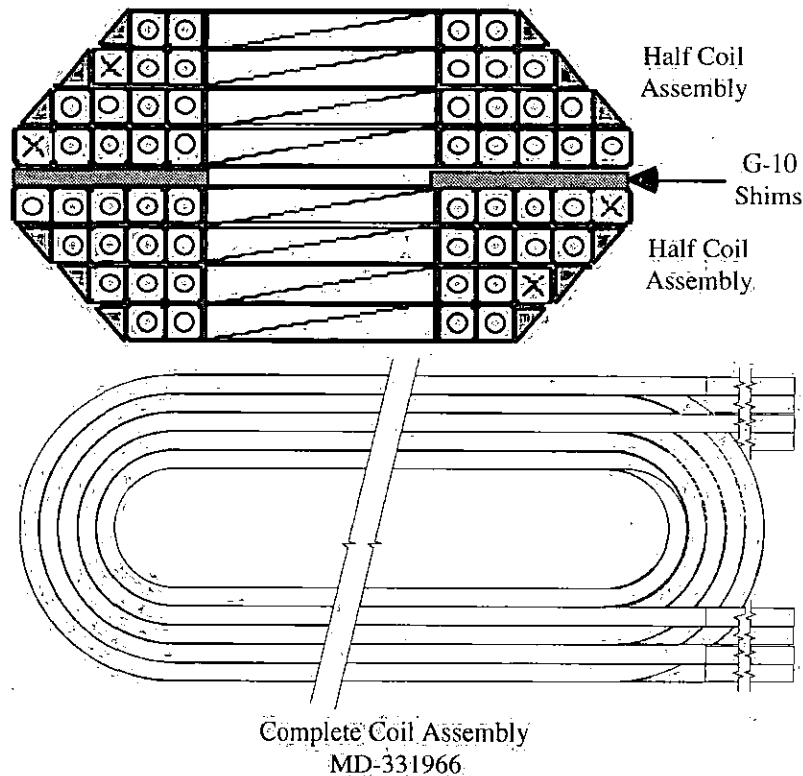
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- 5.2 Using the overhead crane and the appropriate slings, position the other half coil assembly (not inverted) on top of the inverted half coil assembly presently on the wrapping stands. Longitudinally and latitudinally position the two (2) half coil assemblies on top of each other per MD-331966. Then clamp the two (2) half coil assemblies together using c-clamps or other pre-approved clamping methods.

Note(s):

The leads of both half coil assemblies must exit at the same end of the full coil assembly.

_____
Technician(s)_____
Date

Note(s):

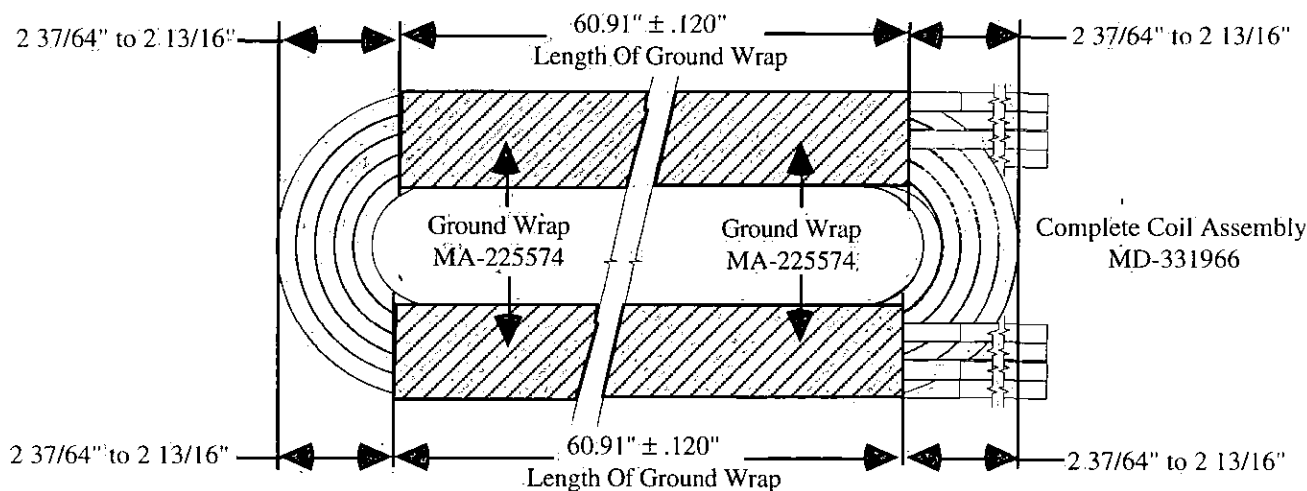
First and second layers of ground wrap insulation may be applied simultaneously.

During the application of the ground wrap, it is the responsibility of the technicians wrapping the coil to perform continual inspections of the area being ground wrapped for but not limited to, damaged insulation, dirt, debris, oil, grease, etc...

- 5.3. Starting $2 \frac{37}{64}$ " to $2 \frac{13}{16}$ " from the end of the coil, apply one layer half-lapped 2" wide X .007 thick Fiberglass Tape (MA-225574) to the straight sections of the coil removing the clamps as you wrap, stopping $2 \frac{37}{64}$ " to $2 \frac{13}{16}$ " from the other end of the coil. Continue in this fashion until the straight sections of the coil have been completely wrapped.

1st Layer Applied

Starting $2 \frac{37}{64}$ " to $2 \frac{13}{16}$ " from the end of the coil, apply one layer half-lapped 2" wide X .007 thick Fiberglass Tape (MA-225574) to the straight sections of the coil; stopping $2 \frac{37}{64}$ " to $2 \frac{13}{16}$ " from the other end of the coil. Continue in this fashion until the straight sections of the coil have been completely wrapped.

2nd Layer Applied**Note(s):**

Adhesive tape is to be removed during the ground wrapping. Transitions between the Fiber Glass (MA-225574) and the Fiber Glass (MA-225574) must be made so that no area of the conductor is uninsulated, but additional build-up of the conductor is minimized.

 Technician(s)

 Date

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- X 5.4 Visually inspect the ground-wrap insulation to ensure uniform application. Perform a visual inspection of the assembly and Electrical inspection, record the results below. The coils are not to be clamped for the following tests.

Inner ID# 2 Coil Serial Number						
Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		6.0 mΩ to 6.8 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		Reference Test Only Not Subject to Limit Values				
Q @ 100 Hz		Reference Test Only Not Subject to Limit Values				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Outer ID# 1 Coil Serial Number						
Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		3.3 mΩ to 3.7 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		Reference Test Only Not Subject to Limit Values				
Q @ 100 Hz		Reference Test Only Not Subject to Limit Values				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				
Hipot Inner Coil to Outer Coil @ 100 Vdc		< 5μA				

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Continued From The Previous Page**Inner ID# 4 Coil Serial Number**

Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		6.0 mΩ to 6.8 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		Reference Test Only Not Subject to Limit Values				
Q @ 100 Hz		Reference Test Only Not Subject to Limit Values				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				

Outer ID# 3 Coil Serial Number

Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Resistance		3.3 mΩ to 3.7 mΩ				
LS @ 1 KHz		Reference Test Only Not Subject to Limit Values				
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values				
LS @ 100 Hz		Reference Test Only Not Subject to Limit Values				
Q @ 100 Hz		Reference Test Only Not Subject to Limit Values				
100 Volt Ring		Reference Test Only Not Subject to Limit Values				
Hipot Inner Coil to Outer Coil @ 100 Vdc		< 5μA				
Hipot Inner Coil to Inner Coil @ 100 Vdc		< 5μA				

Inspector _____

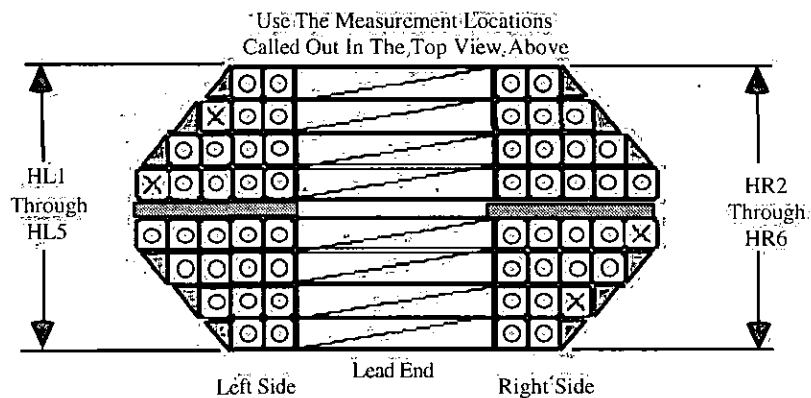
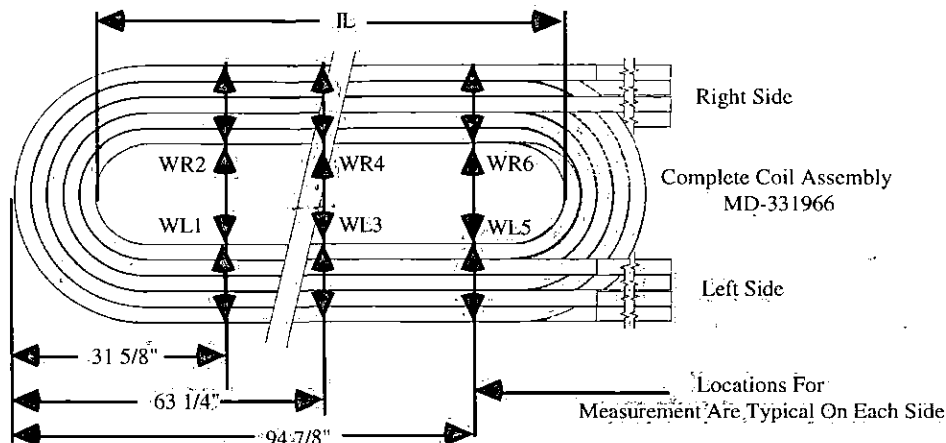
Date _____

Note(s):

If so designated by Engineering a specific core *i.e.*, (a core which exceeds the longest allowable dimension per the core print) maybe used as a Go/Go No gage. If this is the case skip step 5.5 and complete the table provided in step 5.6 on page 21, if not complete the dimensional call out below.

X

- 5.5 Mechanically inspect the coil using a Vernier Caliper (Starrett Part No. 723 or equivalent) at the indicated locations and record your readings in the table provided.

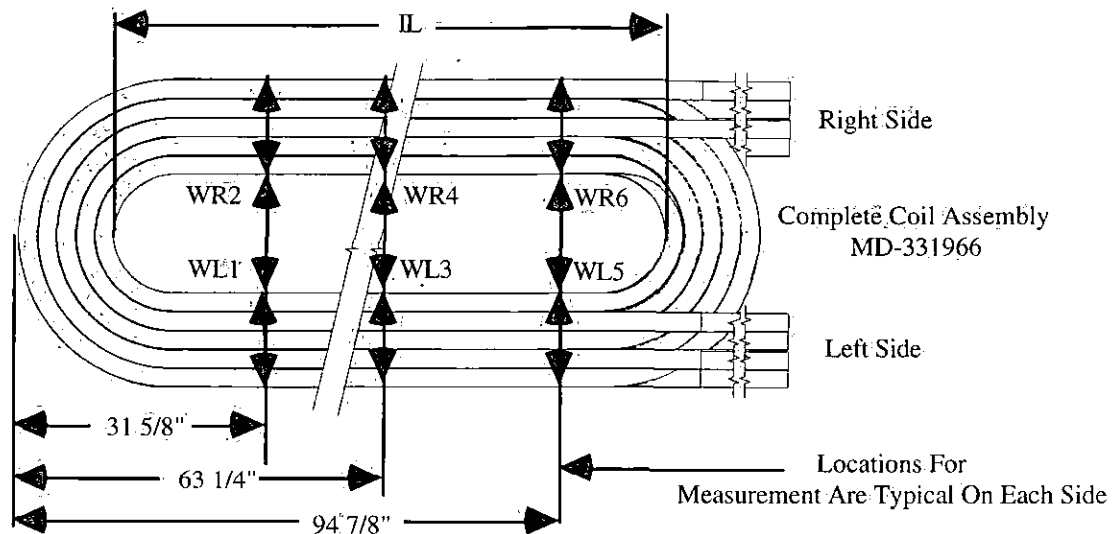


NOTE: Locations HL5 And HR6
Are Located At The Lead End

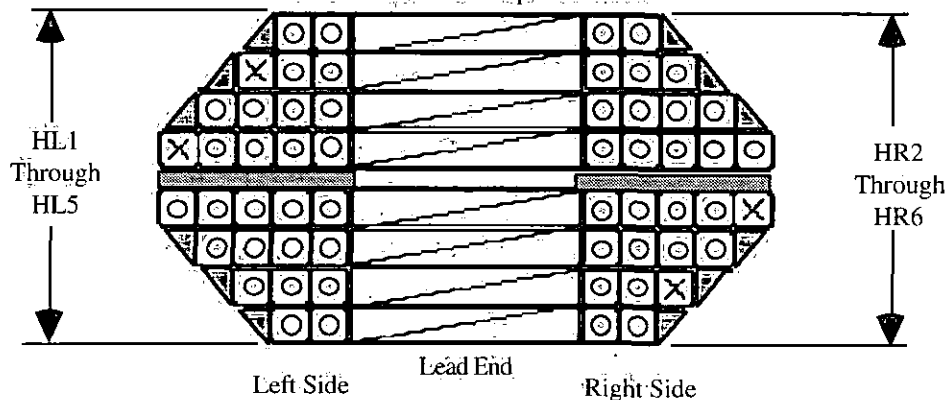
Left Side

Location	Desired Dimension	Measured Dimension	Pass	Fail	Out Of Tolerance
WL1	2.39" to 2.45"				
WL3	2.39" to 2.45"				
WL5	2.39" to 2.45"				
HL1	3.69" to 3.75"				
HL3	3.69" to 3.75"				
HL5	3.69" to 3.75"				

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Use The Measurement Locations
Called Out In The Top View Above

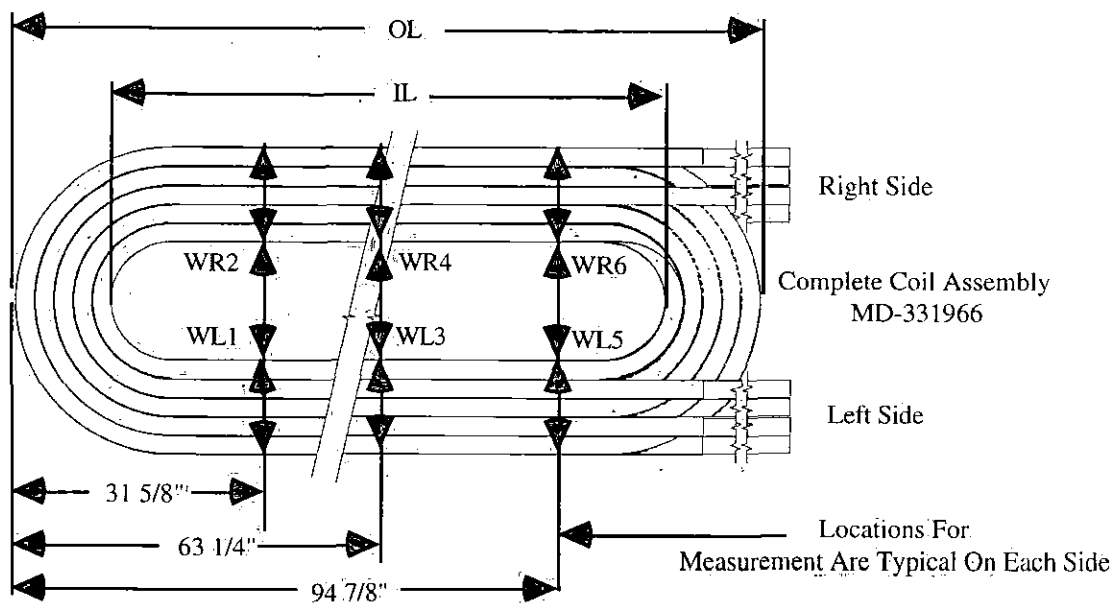


NOTE: Locations HL5 And HR6
Are Located At The Lead End

Right Side

Location	Desired Dimension	Measured Dimension	Pass	Fail	Out Of Tolerance
WR2	2.39" to 2.45"				
WR4	2.39" to 2.45"				
WR6	2.39" to 2.45"				
HR2	3.69" to 3.75"				
HR4	3.69" to 3.75"				
HR6	3.69" to 3.75"				

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Continued From The Previous Page**Inside Measurements**

Location	Desired Dimension	Measured Dimension	Pass	Fail	Out Of Tolerance
WL1 to WR2	2.61" Minimum				
WL3 to WR4	2.61" Minimum				
WL5 to WR6	2.61" Minimum				
OL	66.44" Maximum				
IL	61.60" Minimum				

5.6 Complete the table below using the Go / No Go gage indicated by Engineering.

Go / No Go Gage		
Core Serial Number	Pass	Fail

Inspector _____

Date _____

X 5.7 Visually inspect the coil for the following, which will include but not be limited to:

All materials must be clean, dry, free from grease, oils, etc.

Pass ☐ Fail ☐

The insulation is free of damage and there is no exposed copper.

Pass ☐ Fail ☐

The coils serial numbers are not covered by insulation.

Pass ☐ Fail ☐

Inspector _____

Date _____

- XX 5.8 Verify that the recorded results are in compliance with MD-331984/MD-331966 and ES-331810. Remove the temporary identification labels and scribe the coil serial number on to a Tie Wrap (MB-318794) using a Panduit Marking Pen (PFX-0-Black) and attach the tie wrap to the coil assembly at the lead end. Ensure that the coil serial number matches that at the bottom of this traveler.

Lead Inspector

Date

Crew Chief

Date

- 5.9 Transport the insulated coil on the coil transport cart to the coil staging area for further assembly.

Technician(s)

Date

6.0 Production Complete

- ~~XXX~~ 6.1 Process Engineering verify that the FMI 3Q60 Coil Assembly/Insulation Traveler (5520-TR-333291) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Process Engineering/Designee

Date

- ~~XXX~~ 6.2 Assembly verify that the FMI 3Q60 Coil Assembly/Insulation Traveler (5520-TR-333291) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Assembly/Designee

Date

- 7.0 Attach the Process Engineering "OK to Proceed" Tag on the coil.

Process Engineering/Designee

Date

- 8.0 Proceed to the next major assembly operation - 3Q60 Half Magnet Assembly Traveler (5520-TR-333292).